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DEPLETING PLANT RESOURCES IN THE RAJASTHAN DESERT

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ABSTRACT

Concern for conservation and sustainable use of plant resources has been growing in many countries including India. The inhospitable and erratic climate in the desert ecosystem coupled with the high population of human and livestock make it susceptible to degradation and depletion. These depleting plant resources in the Rajasthan desert are discussed in the paper. Reasons for their depletion and strategies for conservation are detailed below besides a list of 43 rare and threatened taxa of the Rajasthan desert are presented alongwith their phenology and distribution etc.

INTRODUCTION

Floral and faunal diversities are the two facets of biodiversity, which covers the variety and variability of species. Concern for conservation and sustainable use of plant diversity has been growing in many countries, including India. The arid zone of India occupies over 3,20,000 sq km covering *ca* 12% of the country's geographical area. The population of both human and livestock in the deserts being high, coupled with the changing climate adversely affect the delicately balanced ecosystem. This results in an over-exploitation of natural plant resources, which poses a threat to plant diversity, particularly in such fuel starved arid zones. The present paper on the depleting plant resources in the Rajasthan desert is a step in this direction to cover the arid desert ecosystems.

There is a great awareness in the recent times of the need to conserve natural plant resources all over the world that several thousand species of plants and animals are threatened; many are critically rare and a few already extinct. Studies undertaken during the last 3-5 decades on floras in several parts of the world have shown that many plant species are in danger of extinction while some have already become extinct recently. According to the reports given by the International Union for Conservation of Nature and Natural Resources (IUCN) it is estimated that about 10% of world's vascular plant species totalling to about 20,000-25,000 species are under varying degrees of threat. The flora of India is very rich in plant diversity with an estimated 50,000 species of which about 18,000 are flowering plants. Of these, *ca* 5,000 species are endemic to India, while several hundred species are threatened. For analysing the depleting plant resources, we must have a fairly accurate list of such plants. Many species of our flora have not been collected for several years. Several species are only known by their type collections; in some cases even these types do not exist in Indian herbaria. It is necessary to bring out all such lacunae in our collections and knowledge so that intensive search may be made for them in the field or in the herbarium. One of the important sources of information on rare plants is personal knowledge and field observations.

The extinction of hundreds and thousands of life-forms, which are likely to vanish if the current trend in increased human population in the last few decades continues, demanding development in various spheres and resulting directly or indirectly in sudden and often far reaching disturbances in natural ecosystems. The growth of large urban areas, construction activities such as dams, buildings and roads, encroachment on vast areas of forest lands for extension of arable land, shifting cultivation, defence activities and mining operations are examples of direct onslaughts on nature, which have steadily depleted our natural resources. Besides, pollution of air and water resulting from urbanisation, industrialisation, excessive use of chemical fertilizers and pesticides have in no small way, contributed to the environmental eco-imbalances, effecting the very survival of wildlife. Besides the above factors which are responsible for disappearance of plant resources, there are certain natural phenomena *viz.* land upheavals, volcanic eruptions, glaciation, protracted periods of rain or drought, expansion of deserts and forest fires are also responsible for the extinction of plants. The resulting new environmental conditions have also lead to the evolution, speciation and migration of plants. Unplanned commercial exploitation of entire plants, roots, rhizomes, tubers, bulbs, seeds and fruits for rapid financial gains have been the prime cause of depletion of economic plants. Apart from these the vigorous competition with allien weeds and effects of plant pests and diseases have also been sources of threat to several native plants. *Parthenium, Eichhornia* and *Lantana* are some familiar examples of exotic plants adversely affecting our native flora. The tourist spots and pilgrimage centres which attract large crowds also cause damage to the natural flora.

The threat to environmental survival is now engaging the attention of many countries. The recent preparation of Red data books; list of threatened and endemic taxa and symposia organised by various countries in Europe, Africa, North and South America etc., on rarity, endemism and threatened plants have recently stimulated the Asian countries, including India, to look into the fate of their depleting plant resources. In the eleventh technical meeting of IUCN, held at New Delhi in 1969 (IUCN, 1970), the problems of the taxa on the verge of extinction in India were also discussed and needs of the preliminary lists of such taxa were realised to achive the task of conservation. A brief review of work done in India on the threatened plants and habitats has been published by Jain & Sastry (1981). Following this, concerted efforts on the subject were made in the years 1980-85 through programme : Project on Study, Survey and Conservation of Endangered species of Flora (POSSCEF) supported by the U.S. Fish & Wildlife service (under PL-480 scheme) in the BSI and valuable baseline data on nearly 1000 threatedned and endangered plant species have been gathered. Further, a seminar on threatened plants of India was organised by the Botanical Survey of India for the first time in India at Dehra Dun in September, 1981 to evaluate the endemic flora and to assess the status of the threatened taxa in India. Therein Pandey, *et al.* (1983) and Sharma (1983) respectively reported 41 and 106 taxa as rare and threatened taxa from whole of Rajasthan. Singh (1985) dealt with the threatened taxa and their scope of conservation. Recently Singh & Pandey (in press) dealt with the conservation of plant diversity in Rajasthan. Very recently Mondal (1991) has published "Massuria hill — a type locality at Jodhpur in Rajasthan" where he has emphasized that this area harbours a number of new species and varieties. This low hill is under drastic biotic pressure at present. Unkind exploitation leads to serious threat for the survival of the rare and endemic taxa in the area. So immediate steps should be taken to restrict or preserve the area under Government control to avoid massive extinction. The project like Man and Biosphere (MAB) is also working in this direction. A regional workshop on the same subject was again organised by BSI in collaboration with National Bureau of Plant Genetic Resources (NBPGR) at New Delhi in March, 1982. Recently BSI has published the Indian plant Red data book I (Eds. Jain & Sastry, 1984) and three volumes of the Red data book of Indian plants (Eds. Nayar & Sastry, 1987, 88, 89).

LOCATION AND TOPOGRAPHY

The Rajasthan part of the Indian desert, commonly known as the Rajasthan desert, covers a total area of about 1,96,150 sq km between latitudes of 24°40' and 30°12' north and longitude of 60°30' and 75°55' east and occupies nearly 3/5 of the total area of the state. It includes the districts of Sri Ganganagar, Bikaner, Jaisalmer, Barmer, Jodhpur, Churu and parts of Nagaur (96%), Jalore (88%), Jhunjhunu (69%), Sikar (65%), Pali (48%) and Ajmer (9%) districts (Krishnan, 1968 a, b). The eastern limit of this region is marked by the Aravalli ranges tending in north-easternly direction. These ranges divide the regions of western Rajasthan characterised by desertic and sub-desertic climate from the comparatively more damp and fertile regions on the south-east.

The Rajasthan desert has a wide range of habitats, climatic factors, physiography, soil types and geological antiquity. A spectacular feature of the Rajasthan desert is the occurrence of sand-dunes which vary in height from a few metres to about 80 metres. About 58% of W. Rajasthan is covered with sand-dunes of different types, magnitude and orientation. In the northern part of the desert, in Sri Ganganagar district, the Ghaggar alluvial plain is also situated.

The only river of significance in W. Rajasthan is the Luni, an ephemeral river carrying water during the short monsoon period. There are also some fresh water lakes, like Balsamand and Kailana (Jodhpur) and Gajner (Bikaner) etc.

Saline depressions (Playas) or lakes are scattered throughout in W. Rajasthan, the well known ones being Sambhar lake, Pachpadra, Lunkaransar, Kuchaman salt lake and Didwana. In addition, there are many less known local saline tracts like those at Kaparda, Sujangarh, Tal-Chappar, Parihara, Sargot, Mitha-ka-Rann, Kharia Rann, Pokaran, That, Lawan, Khutani, Khanodwala, Kharowala, Phalodi, Mansar and Kodemdesar. The northern tip of the Rann of Kutch butts into Barmer and Jalore districts.

The only canal of significance is "Indira Gandhi canal", which is present in N.W. Rajasthan, playing a very vital role in the economic development of the area at one hand and drastic pressure on the natural desert flora on the other hand. The natural vegetation is affected very severely and many new introductions from the neighbouring states are growing in the canal command area of the Rajasthan desert.

The desert is also having hilly out crops and gravelly rocky plains.

CLIMATE

The Rajasthan desert is characterised by low erratic rainfall, high solar radiation, extreme variations in diurnal and seasonal temperature with high summer temperature, low humidity of the atmosphere for the greater part of the year, high evaporation rates, desicating winds and dust storms during summer, sandy and unretentive character of soil, low water table, general soil and water salinity and all these factors lead to a poor vegetation cover. The mean annual rainfall ranges from about 100 mm in the north-western sector of Jaisalmer district to about 450 mm in Sikar district. The failure of monsoon rains in this region is quite frequent, causing severe famine. As a consequence of high temperature, coupled with the low rainfall, evaporation far exceeds precipitation, with the result there is very little moisture to support vegetation. So the climate also plays a vital role in survival/ depletion of plant resources in the Rajasthan desert.

DISCUSSION

The overall flora of Rajasthan desert comprises 884 indigenous and naturalised vascular plant species belonging to 392 genera spread over 93 families (Pandey, *et al.* 1985).

The present study dealing with depleting plant resources in Rajasthan desert includes endemic, rare, endangered and threatened taxa, along with their probable factors for threat and rarity and scope for conservation in Rajasthan desert. Due to its characteristic topography, geology, climatic and edaphic factors, it maintains a peculiar type of vegetation, not found elsewhere in India. Endemism is also a very common phenomenon in the desert, since about 21 taxa of Angiosperms are endemic to the desert. Among the endemics 7 taxa are of specific level, while 14 are of infra-specific level.

Most of these endemic taxa were reported between 1918-1985. In spite of the absence of any geographical barrier, these species could not spread so widely as expected during such a long time. It is again interesting to note that certain taxa like *Farsetia macrantha, Ipomoea cairica* var. *semine-glabra, Pavonia arabica* var. *massuriensis* and *Digitaria pennata* var. *shettyana* are still confined to their type localities only, and so far they are known from their type collections only. Others also have a very confined distribution (Pandey, *et al. l.c.*). It is probably due to very badly disturbed ecosystem in the desert and due to lower range of adaptibility of these species. Conservation of such taxa need no emphasis; but the work of conservation in the areas like desert is very stupendus, since there are no natural barriers like forest belts, hill ranges etc. On the other hand the threatened plants are very sparsely distributed and the biotic and climatic factors have considerably disturbed the ecosystem. The authors, therefore, recommend that *ex-situ* conservation may give very desirable result. Emphasis should also be given to the establishment of National Parks and sanctuaries, where these can multiply. Thus, there is an urgent need of Desert Botanical Garden in the heart of Desert which may also serve as an intrinsic laboratory of nature for study of phenotypes and genotypes of all species which show some outstanding properties and so also to develop a National Cactarium.

Further, a few of the 16 taxa presumed to be rare and threatened by Pandey, *et al.* (*l.c.*) and Singh & Pandey (in Press) were of course, previously confined to Rajasthan desert which have a comparatively wide range of adaptation and have migrated eastwards to semi-arid climate (E. Rajasthan, Gujarat, Punjab etc.) while some others have migrated westwards to Sind in Pakistan. Some others are wides, though important for Rajasthan (marked with an asterisk* in the list). The danger of extinction of such taxa is rather low. However, the life of these species also may be insured on having a Desert Botanical Garden as suggested above.

Besides the above, over exploitation of certain taxa for various economic uses in Rajasthan has also seriously threatened them. (i) The seeds of *Citrullus colocynthis* (L.) Schrad., "Thumba" "Tumba" yield a non-edible and volatile oil which has found a reputable place in the soap industry and as lubricant. Hence its fruits are indiscriminately collected. Since the plant reproduces by seeds, if this practice will continue for a long period, this species may become endangered. Besides, seeds are also eaten during scarcity. The oil-cake is eaten by the cattle. The pulp is said to be of highly medicinal value. Its cultivation will not only restrict the danger of its vulnerability, but also play a very vital role in the economic development of the state. (ii) *Commiphora wightii* (Arn.) Bhandari is well known for its gum-resin called "Guggal" besides being one of the main source of fire-wood in the desert. Its populations have notably depleted in its entire range of distribution (Rao, *et al.*, 1981; Sahni, 1970). (iii) Similarly, *Ephedra foliata* Boiss., the only living indigenous gymnosperm in the desert, is on the verge of vulnerability. It is being used as fire-wood on large scale. The present collections in different herbaria revealed that the number of female plants is rather low in this area, hence inadequate reproductive mechanism may also be one of the reasons for its rarity. The populations have shrunk to a great extent in its entire range of distribution from India to Syria. (iv) *Tecomella undulata* (Sm.) Seem., locally called "Marwar Teak" or "Rohira" is the main source of timber in the desert. Observations have revealed that its regeneration capacity is also very low; once the plant is cut, it is cut for ever. Under such conditions, the survival of this taxon is also unlikely if such factors will continue operating (Sahni, *l.c.*). Thus maximum afforestation of such an economically important tree is most essential to balance the ecosystem in the desert. (v) *Calligonum polygonoides* L., locally called "Phog, Phogro" is extensively used as a fire-wood in the desert. Its flower buds are also used with curd as a cold drink. Its populations are also under depletion if current trend will continue. There should be an immediate ban on its cutting and some other alternative source of fire-wood should be introduced in the desert; and (vi) *cordia crenata* Delile "Gundi" is considered an extinct species at present. This may perhaps be due to its edible fruits besides its use as fire-wood.

ECONOMIC AND MEDICINAL PLANTS

The flora of the Indian desert consists of many economically useful and medicinally important plants whose proper scientific management and exploitaition can lead to economic development and upliftment of the area. The study of such plants in the desert area has drawn the attention of several workers. However, Singh & Pandey (1983) may be referred for this, who deal with 194 species belonging to 131 genera under 53 families of economic and medicinal plants of the Indian desert which may provide food, fibre, timber, fire-wood, medicines and several minor forest products like tannin, dye, gum-resin, mucilage, detergent and soap substitutes, non-edible oil, spirit and raw material for paper etc. Over-exploitation of some of these plants has already been discussed above, which if unchecked will deplete the local plant resources. While others also should be exploited in a sustainable manner which shall keep the diversity of the desert enriched.

CONSERVATION MEASURES

For the task of preserving our depleting plant resources like rare and endangered species we must first of all have a list of such plants. The present account is based on the collection deposited in the various Indian herbaria, published literature and on the personal experience of the authors as a result of their botanical explorations in various parts of Rajasthan, particularly in the desert. A critical study of some of the taxa included here will, however, have to be undertaken to determine their taxonomic status. Further work will prove it necessary to add other species to the present list or delete some from the list. Extensive botanical explorations to search for certain taxa in their original natural habitats will also have to be carried out to ascertain if they are already extinct or are endangered.

The problem of habitat destruction is serious in a vast country like India, particularly in the fuel starved desert of Rajasthan. Therefore, large areas must be set aside as biological reserves, if massive extinctions are to be avoided. The establishment of the Desert National Park in Jaisalmer and Barmer districts of Rajasthan, will certainly prove to be beneficial in conserving some of the depleting plant species of Rajasthan desert. This Desert National Park extending over an area of about 3,162 sq km has recently been established (in fact it is yet to be notified officially) in Western Rajasthan to preserve the flora & fauna of the "Thar desert" particularly the endemic, rare and threatened taxa and so also to restore the degraded natural ecosystem. It has all the characteristis of the desert ecosystem. The topography here is primarily dominated by stabilised, semi-stabilised and unstabilised sand-dunes, with wide interdunal gaps. Local grasses, shrubs and trees are being planted to enrich the diversity. Pandey, *et al.* (1985) and Shetty & Pandey (1988) who deal with this park in details mention 168 taxa of angiosperms belonging to 111 genera under 45 families. This park will be of great significance in conserving the rare and threatened taxa of the desert area, as 17 of the 43 taxa enumerated below already occur in this park area. Attempts should also be made to introduce here as many more taxa as possible of the remaining rare and threatened plants of western Rajasthan, particularly of the desert before they are lost to posterity.

There is a proposal to raise this Desert National Park to the level of Biosphere Reserve, which is a most welcome step in conservation strategy. Besides, more reserves must be created in different ecozones for *in-situ* protection of rare and threatened taxa. Establishment of a Desert Botanical Garden for *ex-situ* conservation should also be seriously considered. Efforts must be made to control human pressure on the desert ecosystem and so also the animal number should also be kept under check so as to have a sustainable grazing policy in the area. More judicious use of water and land must be adopted so as to get the best according to the land capability and fodder production. Alternative sources of energy like biogas and economic stoves must be tried in the area. Alternative sources of employment like tourism, cottage industry and fish farming etc., should also be developed to release pressure on existing land. A viable policy for mining also needs to be worked out. Needless to say that all this must be carried out by engendering popular local support, through non-Governmental organisations, if need be. Then only we can think of a richer desert ecosystem and preservation of the plant resources of the Rajasthan desert.

ENUMERATION

In the enumeration below 42 taxa of Angiosperms besides a Gymnosperm are listed alphabetically; for each taxon, the correct aurhority followed by family name in bracket, local names, if any, characteristic features, habitat, flowering and fruiting time and the maximum known range or distribution is given, followed by notes, if any.

Abutilon bidentatum Hochst. ex A. Rich. var. **major** (Blatt. & Hallb.) Bhandari (Malvaceae).

Very similar to var. proper, but can be identified by about 20 × 17 cm leaves and up to 17 cm long petioles. Rare, in waste places and fallow fields.

Fl. & Fr. : Sept. Dec.

Distrib. : Endemic to W. Rajasthan in Barmer, Jaisalmer and Jodphur districts.

A. fruticosum Guill. & Perr. var. **chrysocarpa** Blatt. & Hallb. (Malvaceae).

Very similar to var. proper, but can be identified by the golden-yellow and densely stellate hairy schizocarps. Rare, in rocky habitats.

Fl. & Fr. : Nov. Dec.

Distrib. : Endemic to W. Rajasthan in Jaisalmer district.

Alysicarpus monilifer (L.) DC. var. **venosa** Blatt. & Hallb. (Fabaceae).

This can be differentiated from var. proper by having reticulately venied, 8-jointed pods. Rare, in sandy soils.

Fl. & Fr. : Oct. Nov.

Distrib. : Endemic to Rajasthan in Jaisalmer and Kota districts.

Ammannia desertorum Blatt. & Hallb. (Lythraceae) *''Moto-Jal-Bhangro''*.

Coarse, scabrous, papillose herbs; branches sharply quadrangular and narrowly winged above. Flowers in 1-6-flowered, sessile, axillary cymes. Capsules reddish-brown, transparent. Rare, in moist habitats.

Fl. & Fr. : Jan. Dec.

Distrib. : Pakistan, India (Rajasthan, Saurashtra).

Anogeissus serica Brandis var. **nummularia** King ex Duthie (Combretaceae) *"Dhauro, Indoko"*.

Small trees; tender branches and leaves rusty-silky pubescent. Leaves ovate to obovate, less than 2 cm long. Wings of fruits jagged at the apex only, with semi-persistent calyx-cup. Rare, in dry habitats.

Fl. & Fr. : Sept. Jan.

Distrib. : W. Rajasthan and Punjab.

Anticharis glandulosa Aschers. var. **caerulea** Blatt. & Hallb. (Scrophulariaceae).

Erect, branched herbs, clothed with viscid-glandular hairs. Leaves upto 2.5 × 1.25 cm. Flowers pink, rosy or blue, axillary, solitary or 2-together; pedicels less than twice as long as the calyx. Rare, in rocky habitats.

Fl. & Fr. : Sept. Nov.

Distrib. : Endemic to W. Rajasthan in Jaisalmer district.

Note : The plant produces a sort of oily secretion to such a great extent that the ground below the plant appears more or less greasy.

Aristida royleana Trin. & Rupr. (Poaceae).

small, tufted annuals, 10-20 cm. Leaves flat or convolute. Panicles effuse. Spikelets 10-14 mm long. Articulation between lemma and awn present; column of awns about 15 mm long. Rare, found in sandy habitats.

Fl. & Fr. : Sept. Nov.

Distrib. : Pakistan, North-west India.

Barleria prionitis L. subsp. **prionitis** var. **dicantha** Blatt. & Hallb. (Acanthaceae).

Armed, glabrescent, bushy undershrubs, with whitish bark. Flowers showy, yellow in terminal, dense, spikes; bracteoles spine-tipped. Capsules ovoid, beaked, glabrous. Rare, on low hillocks and in rocky habitats.

Fl. & Fr. : Aug. March.

Distrib. : Endemic to Rajasthan in Barmer, Jodhpur, Alwar, Bhilwara and Tonk districts.

***Calligonum polygonoides** L. (Polygonaceae) *"Phog"* (Plate 1)

Rigid, much-branched shrubs. Stipules short, membranous, cup-shaped, obliquely truncate and produced upwards at one side. Flowers pink. Fruits densely clothed with reddish-brown bristles. Fairly common on sandy-dunes.

Fl. & Fr. : April May.

Distrib. : Iran, Syria, Sind in Pakistan and North-west Rajasthan in India. Due to over exploitation it is a vulnerable species in India.

Note : The wood is used as fuel, in huts, wells etc. The flowering buds are locally used as "Raitta" along with the curd during the hot summers. The coal prepared from this plant is locally used by iron-smiths and gold-smiths.

Caralluma edulis (Edgew.) Benth. & Hook. f. (Asclepiadaceae) *"Pimpa"*

Erect, succulent herbs. Leaves linear or ovate-lanceolate, caducous. Flowers 1-3, in the axils of leaves. Corolla purplish inside; corona in two rows. Follicles up to 15 cm long, smooth, terete. Seeds winged on the margins, comose. Very rare in desertic habitats.

Fl. & Fr. : Feb. Sept.

Distrib. : Pakistan, India (W. Rajasthan in Jaisalmer district).

Cenchrus prieurii' (Kunth) Maire var. **scabra** Bhandari (Poaceae) *"Lambo-bhurat"*.

This can be differentiated from var. proper by having inner bristles of the involucels not ciliate towards the base but scabrous throughout. Not common, in sandy to gravelly-rocky habitats.

Fl. & Fr. : Oct. Dec.

Distrib. : Endemic to W. Rajasthan in Jaisalmer, Jodhpur and Barmer districts.

C. rajasthanensis Kanodia & Nanda (Poaceae).

Erect or geniculately ascending, caespitose annual or biennial grasses, up to 30 cm. Ligule a fringe of hairs. Inflorescence up to 6 cm long, with angular and glabrous rachis. Bristles of the involucel antrorsely scabrid, few or absent. Caryopsis *ca* 2 mm long, ovoid-oblong. Very rare, in sandy habitats.

Fl. & Fr. : Aug. Oct.

Distrib. : Endemic to Western Rajasthan in Jaisalmer and Jodhpur districts.

***Citrullus colocynthis** (L.) Schrad. (Cucurbitaceae) *"Tumbo"*.

Trailing, scabrid, perennial herbs. Leaves deltoid, deeply 3-5-lobed, tendrils simple or bifid, sparsely villous. Flowers yellow. Fruits globose, variegated green, mottled with yellowish blotches, with bitter pulp. Seeds compressed, smooth, pale-brown. Common in sandy to gravelly-rocky habitats in desertic zones.

Plate 1. *Calligonum polygonoides* L. — A vulnerable species in W. Rajasthan desert.

Fl. & Fr. : Jan. Dec.

Distrib. : Spain, Arabia, Africa, West Asia, Sri Lanka, Sind in Pakistan and India. Due to over exploitation of its seed-oil, it is also a vulnerable species in Rajasthan.

Note : The seeds yield a non-edible oil which is used in soap-industries, varnishes etc. The seed-cake eaten by cattle.

Cleome gynandra L. var. **nana** (Blatt. & Hallb.) Bhandari (Cleomaceae).

Dwarf herbs, up to 10 cm. Leaves glabrous except the glandular margins. Flowers white to pinkish. Rare, in sandy habitats.

Fl. & Fr. : July Sept.

Distrib. : Endemic to W. Rajasthan in Jaisalmer and Jodhpur districts.

***Commiphora wightii** (Arn.) Bhandari (Burseraceae) *"Guggal"*.

Tall, bushy, spinous, deciduous shrubs; bark peeling-off in flakes. Leaflets 1-3, rhomboid-ovate, serrate near the apex. Flowers solitary or in fascicled cymes, brownish-red. Drupe ovoid, minutely beaked, deep-red. Rare, on the open dry hills and in rocky habitats.

Fl. & Fr. : Jan. May.

Distrib. :- Arabia, Pakistan, India (Rajasthan and Gujarat). A vulnerable taxon in Rajasthan.

Note : The plant is a source of gum-resin, which is used in perfumery and local medicines. The tender branches are also used as tooth brushes.

Convolvulus auricomus (A. Rich.) Bhandari var. **ferruginosus** Bhandari (Convolvulaceae).

Twinning herbs, ferruginously silky-hairy. Rare, in dry sandy soils.

Fl. & Fr. : Oct. Nov.

Distrib. : Endemic to W. Rajasthan in Barmer, Jaisalmer and Jodhpur districts.

Convolvulus auricomus (A. Rich.) Bhandari var. **volubilis** (C. B. Clarke) Bhandari (Convolvulaceae) *"Rota bel, Ratan jot"*.

Twining, white-hairy herbs. Flowers in heads, with bracts, sepals and petals all larger in comparison to var. proper. Not common, in waste lands and on the fences of cultivated fields.

Fl. & Fr. : Oct. Nov.

Distrib.: Pakistan, India (W. Rajasthan in Barmer, Jaisalmer and Jodhpur districts).

C. blatteri Bhandari (Convolvulaceae).

Prostrate or ascending hirsute, perennial herbs. Flowers in condensed, axillary, pedunculate cymes. Corolla shorter or equal to the calyx. Seeds tuberculate. Rare, in dry sandy habitats.

Fl. & Fr. : Sept. Dec.

Distrib. : Endemic to W. Rajasthan in Jaisalmer district.

C. scindicus Stocks (Convolvulaceae) *''Kaland''*

Erect undershrubs, densely hirsute with brown-grey ferruginous hairs. Leaves sessile, spathulate. Flowers white with pinkish bands, in congested heads. Corolla lobes with a tuft of hairs at the tip. Rare, in wastelands.

Fl. & Fr. : Nov. March.

Distrib. : Pakistan, India (W. Rajasthan in Barmer district). A very rare taxon.

C. stocksii Boiss. (Convolvulaceae).

Erect, annual, silky-hairy herbs. Leaves linear, acute, basal leaves spathulate. Flowers pink-rose, in axillary cymes. Calyx glabrous. Capsules subglobose, glabrous. Seeds grey-pubescent. Very rare, in rocky habitats.

Fl. & Fr. : Sept. Nov.

Distrib. : Pakistan (Baluchistan, Sind), India (Gujrat and North-West Rajasthan).

Cordia crenata Delile (Cordiaceae) *"Gundi"*.

Large shrubs of small trees, wholly glabrous except inflorescence. Leaves with margins crenate-dentate. Flowers in cymes. Drupes ovoid, acute. Very rare, confined to the forests of Barr (Pali district in Rajasthan).

Fl. & Fr. : Jan. April.

Distrib. : Probably this taxon is on the varge of extinction in its native home. Only once collected from Pali district by *Duthie* 4754-A (DD) in Jan. 1886. After that there is no subsequent collection of this species.

Digitaria pennata (Hochst.) T. Cooke var. **shettyana** Pandey, Parmar *et* Vyas (Poaceae).

It can be distinguished from the var. proper by having rachis glabrous throughout. Rare, in rocky habitats.

Distrib. : Endemic to W. Rajasthan in Jalore district.

***Dipcadi erythraeum** Webb. & Benth. (Liliaceae).

Bulbous, scapigerous herbs. Leaves narrowly linear. Scape up to 20 cm long. Flowers greenish in lax, bracteate racemes. Capsules orbicular, flat, black. Very rare, in rocky habitats.

Fl. & Fr. : Aug. Sept.

Distrib. : Canary Island, Arabia, Egypt, Pakistan (Sind), India (Barmer and Jodhpur districts).

***Ephedra foliata** Boiss. (Gnetaceae). *''Lana'', ''suo-phogro'' ''Andho khimp''.*

Dioecious, nuch-branched climbing shrubs. Leaves 2-3 at each node, setaceous. Male flowers many, tetragonous, bracteate; staminal column shortly exserted. Female flowers in sessile, 2-3-flowered cymes of fascicles. Fruits ovoid-globose, milky-white, semi-transparent, fleshy. Seeds plano-convex, brown. Not common, in sandy to racky habitats.

Fl. & Fr. : March- May.

Distrib.: Syria, Afghanistan, Pakistan, India (Punjab and Rajasthan). A vulnerable species in Rajasthan.

Note : The fruits are said to be eaten during scarcity.

Euphorbia jodhpurensis Blatt. & Hallb. (Euphorbiaceae).

Erect, annual, glabrous herbs. Stems dichotomously branched, filiform, straw-coloured. Leaves linear-oblong, margins usually spinulose-serrate. Involucre solitary, axillary, glabrous. Capsules glabrous, rare in sandy habitats.

Fl. & Fr. : Sept. Nov.

Distrib. : Pakistan, India (North-West Rajasthan in Barmer, Jodhpur and Sri Ganganagar districts).

Farsetia macrantha Blatt. & Hallb. (Brassicaceae) *"Motio-hiranchabbo"*.

Canescent, rigid undershrubs. Leaves upto 7.0 × 2.5 cm, broadly linear-lanceolate, petioles upto 1 cm long. Flowers 1.25 1.5 cm across, creamy white to pinkish-white. Siliquae with 2 seriate seeds. Seeds compressed, brown. Very rare, on low hills, in rocky habitats.

Fl. & Fr. : Oct. Jan.

Distrib. : Endemic to W. Rajasthan in Barmer district. Known only from its type locality.

Ipomoea cairica (L.) Sweet var. **semine-glabra** (Blatt. & Hallb.) Bhandary (Convolvulaceae).

This can be differentiated from var. proper by its glabrous seeds. Very rare, in wastelands near habitations.

Fl. & Fr. : Aug. Nov.

Distrib. : Endemic to W. Rajasthan in Jaisalmer district; so far not recollected after its type collection.

Melhania futteyporensis Munro ex Mast. var. **major** (Blatt. & Hallb.) Santapau (Sterculiaceae). (Plate 2)

Cinereo-tomentose, branched herbs. Leaves more than 8 × 6 cm; petioles more than 4 cm long and stipules more than 5 mm long. i.e. leaves, petioles and stipules are much longer than the var. proper. Occasional, found on sand-dunes and rocky hillocks.

Fl. & Fr. : Oct. Nov.

Distrib. : Endemic, found in Barmer, Chittorgarh, Jodhpur and Kota districts in Rajasthan.

M. magnifolia Blatt. & Hallb. (Sterculiaceae).

Suffruticose, stellately-tomentose undershrubs. Leaves upto 12 × 5 cm, ovate-oblong, crenate-dentate. Flowers orange-yellow. Capsules sub-globose, densely tomentose, with persistent calyx. Seeds angular, brown. A very rare species, in rocky habitats.

Fl. & Fr. : Sept. Dec.

Distrib. : Endemic, found in Barmer, Jodhpur, Kota and Jhalawar districts in Rajasthan.

Merremia rajasthanensis Bhandari (Convolvulaceae).

Trailing or twining, glabrous, annual herbs. Stems 3-winged. Leaves pedately divided up to the base, 5-lobed, acuminate. Flowers white. Filaments dilated and glandular hairy at base. Capsules sub-globose, light brown. Seeds trigonous, smooth, glabrous. Rare, on the fences, in sandy to rocky habitats.

Fl. & Fr. : Aug. Sept.

Distrib. : Endemic to N.W. Rajasthan (Jodhpur and Barmer districts).

***Monsonia heliotropioides** (Cav.) Boiss. (Geraniaceae). *"Mayur-shikha"*.

Hoary, annual herbs, with woody rootstock. Leaves mostly radical, petiolate, ovate or rhomboid, obtuse, denticulate, villous on both surfaces. Flowers unbellate, pink; petals shorter than the sepals. Capsules stipitate, with a long

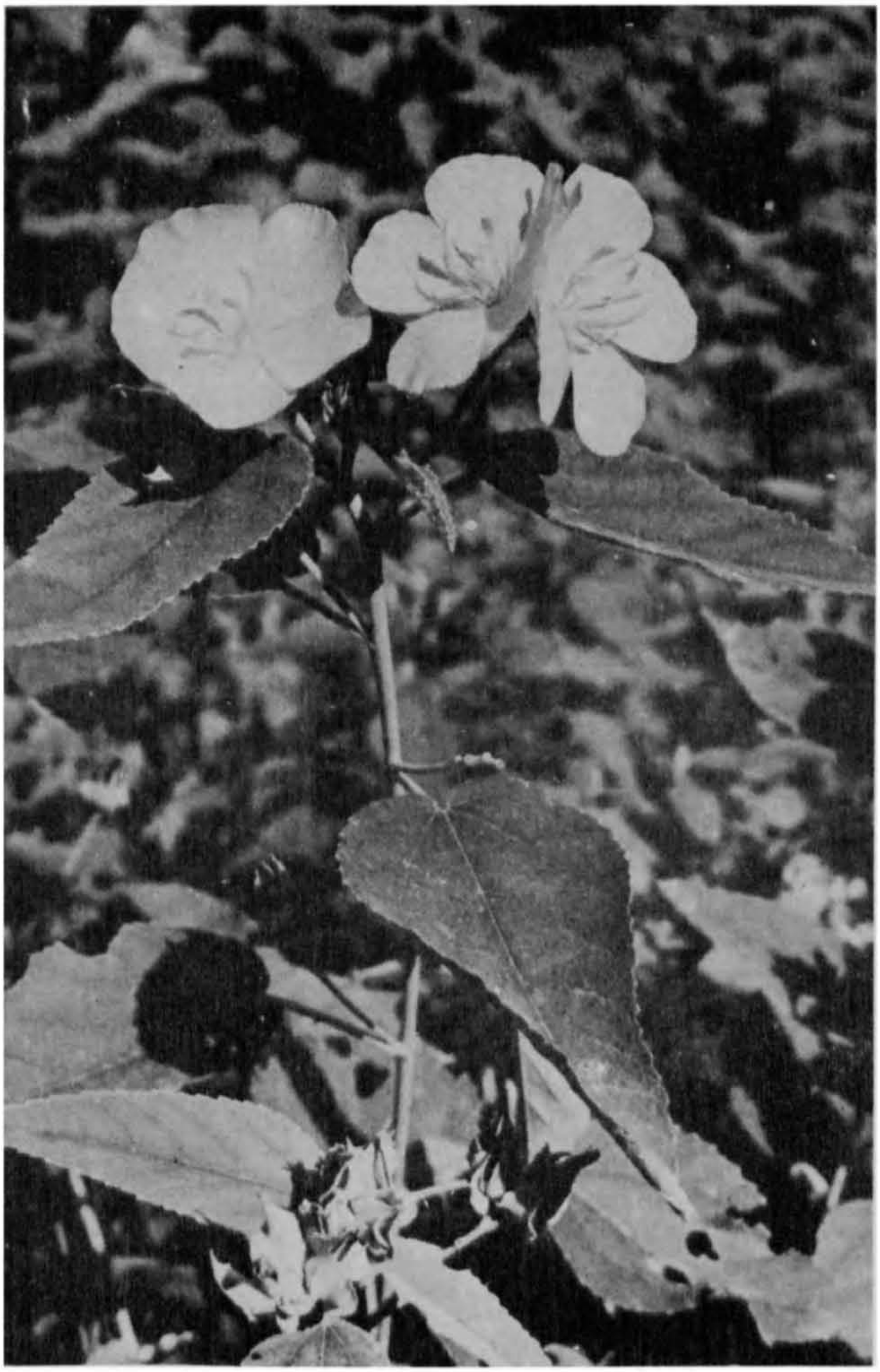

Plate 2. *Melhania futteyporensis* Munor var. *major* (Blatt. & Hallb.) Santapau — A rare species.

beak, clothed with long, silky hairs within. Rare, in gravelly-rocky habitats.

Fl. & Fr. : Aug. - Sept.

Distrib. : Egypt, Pakistan (Sind), India (Bikaner and Jaisalmer districts).

***Odontanthera varians** (Stocks) Mabberley (Asclepiadaceae) *"Dodha"*

Small, erect, annual or perennial herbs. Leaves hairy on both surfaces. Flowers white or yellow in subsessile, unbellate cymes. Corona-lobes entire or bifid. Follicles up to 5 cm long, ellipsoid, covered with soft, scattered spines. Not common, in rocky gravelly habitats.

Fl. & Fr. : Aug. Dec.

Distrib. : Arabia, Bahrin Island, Iran, Sind in Pakistan, India (W. Rajasthan in Barmer and Jaisalmer districts).

Panicum nehruense Jauhr. & Joshi (Poaceae).

Robust, erect to decumbent grass with pubescent and red-coloured nodes. Leaves linear-lanceolate, densely hirsute; ligule membranous, densely ciliate. Panicles up to 25 cm long, effuse. Spikelets tinged with purple. Rare, in sandy habitats.

Fl. & Fr. : Sept.- March.

Distrib. : Endemic to W. Rajasthan in Jodhpur district.

Note : This is closely allied to *Panicum coloratum* L., but can be separated by its habit, morphological features, characters of epidermal pattern and cytological characteristics including the chromosome numbers.

Pavonia arabica Hochst. ex Steud. var. **glutinosa** Blatt. & Hallb. (Malvaceae).

It can be separated from var. proper by the plants being densely viscous-pubescent. Occasional, in sandy to rocky habitats.

Fl. & Fr. : Aug. Oct.

Distrib. : Endemic to W. Rajasthan in Barmer, Jaisalmer and Jodhpur districts.

P. arabica Hochst. ex Steud. var. **massuriensis** Bhandari (Malvaceae).

This can be differentiated from the var. proper by having petals being deeply bilobed up to the base. Very rare, in rocky habitats.

Fl. & Fr. : Aug. - Oct.

Distrib. : Endemic to W. Rajasthan in Jodhpur district. Known only form its type locality.

Psoralea odorata Blatt. & Hallb. (Fabaceae) *"Jhil"*

Under-shrubs with pubescent, gland dotted stems. Leaflets 3-foliolate, linear-oblong to obovate, irregularly sinuate-toothed, gland-dotted beneath. Flowers yellow or white. Pods ellipsoid, densely hairy, enclosed by persistent calyx 1-seeded. Rare, in the dry sandy habitats.

Fl. & Fr. : Nov. March.

Distrib. : Pakistan, India (W. Rajasthan).

Pulicaria rajputanae Blatt. & Hallb. (Asteraceae) *"Dhola ligru"*.

Perennial herbs, woody at the base. Stems terete, densely woolly-white. Heads yellow, solitary or in corymbs. Pappus six times longer than achenes. Rare, in saline habitats, particularly on the drying up banks of tanks, pools, ponds etc.

Fl. & Fr. : Oct. Jan.

Distrib. : Endemic to W. Rajasthan in Barmer, Jaisalmer and Jodhpur districts.

Sida tiagii Bhandari (Malvaceae) *"Bal"*.

Densely-stellately tomentose, much-branched perennial undershrubs. Leaves ovate-oblong to obovate, rounded or truncate at apex, entire. Flowers pale yellow. Mericarps 7 8, strongly rugose on the back, woody, enclosed by the persistent calyx. Occasional, in sandy habitats.

Fl. & Fr. : Aug. Dec.

Distrib. : Pakistan, India (W. Rajasthan in Barmer, Jaisalmer and Jodhpur districts). It is a very rare species in the desert.

***Tecomella undulata** (Sm.). Seem. (Bignoniaceae) *"Rohiro", 'Rohira", "Dhora or sagwan"*

A medium-sized tree with drooping branches. Leaves with undulate margins. Flowers yellow or orange yellow in few-flowered cymes. Capsules up to 30 × 1.25 cm, linear, curved, smooth. Seeds winged. Found in sandy habitats.

Fl. & Fr. : Jan.   April.

Distrib. : Arabia, Pakistan, India (Maharashra, Gujarat and Rajasthan). This is a vulnerable species in Rajasthan due to its high timber value. The leaves are grazed by cattle and the bark is used locally in medicine.

Tephrosia falciformis Ramaswami (Fabaceae) *"Rati-Biyani"*.

Perennial, much-branched, pubescent shrubs. Leaves imparipinnate, up to 12.5 cm long with 5   17 leaflets. Flowers purple-red, in terminal, lax racemes. Pods up to 10 cm long, falcate or circinate, densely pubescent, mucronate. Seeds obscurely reniform, glaucous. Rare, in sandy habitats.

Fl. & Fr. : Aug.   Oct.

Distrib. : Pakistan (Sind), India (Rajasthan).

Tribulus rajasthanensis Bhandari *et* Sharma (Zygophyllaceae).

Prostrate to procumbent, annual or perennial hirsute herbs. Leaflets 4-7 pairs. Flowers yellow. Fruits *ca* 1.5 cm across. Mericarps with 2 major divergent spines and 20   30 minor spines; basal pair of spines always absent. Occasional, in sandy to gravelly habitats.

Fl. & Fr. : Aug.   Nov.

Distrib. : It was described from W. Rajasthan (Jodhpur and Jaisalmer districts) but its distribution now extends southwards to Gujarat and westwards to Pakistan.

***Withania coagulans** (Stocks) Dunal (Solanceae) *"Paneer-bandh"*.

Rigid, ashy-grey, stellate tomentose undershrubs, 30-90 cm. Leaves coriaceous, petiolate, elliptic-lanceolate or oblanceolate obtuse, attenuate at base, entire, stellately hairy on both surfaces. Flowers unisexual. Berry globose, smooth, surrounded with accrescent calyx. Seeds ear-shaped, glabrous. Very rare, found in wastelands.

Fl. & Fr. : Nov.   March.

Distrib. : Afghanistan, Pakistan (Baluchistan, Sind), India (Rajasthan in Jodhpur and Jaisalmer districts).

The fruits of this plant are used by the local people for coagulating the milk. In Jodhpur, only sterile plants are observed.

Ziziphus truncata Blatt. & Hallb. (Rhamnaceae) *"Boti"*.

Small, spinous shrubs of medium-sized trees, with divaricate-branches. Leaves truncate at the apex, 3-nerved. Stipular prickles 2, tomentose. Flowers greenish-yellow, in short axillary cymes. Drupes *ca* 7.5 mm across, globose, yellow when ripe. Not common, in sandy to rocky habitats.

Fl. & Fr. : Oct. - Jan.

Distrib. : Endemic to W. Rajasthan (Jaisalmer and Jodhpur districts).

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